

5 **[0001]** The disclosure of Japanese Patent Application No. 2003-024432 filed on
January 31, 2003 including the specification, drawings and abstract is incorporated herein
by reference in its entirety.

[0002] The present invention generally relates to a seat belt warning apparatus that generates an alert sound to alert, or remind, a vehicle occupant that his or her seat belt is unbuckled. More specifically, it relates to the same apparatus configured to generate the alert sound in a different way depending upon each warning level, and a method corresponding to the operation of such an apparatus.

20 **[0003]** One known system (see US Patent Publication No. 6,278,358) triggers an alert sound in two steps to remind an occupant that his or her seat belt is unbuckled depending upon the vehicle speed. Typically, a warning system of this kind starts up when the ignition is turned on, and determines the seat belt to be in the buckled condition in response to a corresponding seat belt buckle switch turning on. With such a system, 25 therefore, the alert sound sounds from the ignition turning on until the seat belt buckle switch turning on.

[0005] With this system, however, if a different alert sound is used for each audible alert (i.e., primary audible alert, secondary audible alert), the occupant may not realize that

the secondary audible alert is alerting him or her that his or her seat belt is unbuckled due to other audible indications indicating the headlight still remaining "ON", etc. This situation is more likely when the primary audible alert is deactivated within 8 seconds as required in the above-stated US regulation, because there is a time period of no alert (i.e., alert sound) from the end of the primary audible alert to the beginning of the secondary audible alert.

[0006] It is true that the occupant can easily associate both the primary and secondary audible alerts with the unbuckled seat belt if the same alert sound is generated in the same way for each alert. This would however make it impossible to provide a classified alert system capable of producing a higher warning level alert when the vehicle is running than when the vehicle is stationary. Also, it should be appreciated that, if the same alert sound is generated in the same way during the primary audible alert as the secondary audible alert that is a relatively strong warning, that excessively strong primary audible alert may annoy the occupant because it is activated almost every time he or she starts the vehicle.

[0007] Thus, it is difficult to achieve such a classified seat belt alert system which assures the occupant's correct recognition of each audible alert.

SUMMARY OF THE INVENTION

[0008] To solve the above-mentioned problems, the present invention has been made to provide a seat belt warning apparatus for a vehicle occupant, which provides an audible alert corresponding to each different warning level.

[0009] To achieve this object, a first aspect of the invention relates to a seat belt warning apparatus for a vehicle occupant including a seat belt, an audible indicator for generating an alert sound having prescribed frequencies and volume, and a controller for providing via the audible indicator, either one of a first audible alert corresponding to a first warning level and a second audible alert corresponding to a second warning level that is higher than the first warning level when the seat belt is unbuckled. The controller is adapted to sound a first alert chime by repeating the alert sound at a first cycle during the first audible alert, and a second alert chime by repeating the same alert sound at a second cycle that is different from the first cycle, during the second audible alert.

[0010] According to this apparatus, the same alert sound (frequency, volume) is used during each audible alert. Thus, the occupant can easily realize that the alert is alerting

him or her of the unbuckled seat belt. Moreover, a plurality of audible alerts can be provided by only repeating the alert sound at different cycles in accordance with the warning level.

5 **[0011]** It should be noted that the cycle of repeating the alert sound is changed by changing the length of generating each alert sound, as well as by changing the time interval at which the alert sound is repeated.

10 **[0012]** A second aspect of the invention relates to a seat belt warning apparatus for a vehicle occupant including a seat belt, an audible indicator for generating an alert sound, a controller for a controller for providing either one of a first audible alert corresponding to a first warning level and a second audible alert corresponding to a second warning level that is higher than the first warning level when the seat belt is unbuckled. This controller is adapted to sound via the audible indicator an alert chime corresponding to the first warning level before an alert chime corresponding to the second warning level during the second audible alert.

15 **[0013]** According to the second aspect of the invention, in a case where the secondary audible alert should be activated after the primary audible alert was stopped so as to comply with the above-stated US regulation, sounding the alert chime corresponding to the first warning level (i.e., lower warning level), with which the occupant is relatively familiar, prior to the alert chime corresponding to the second warning level (i.e., higher warning level) makes it easier for the vehicle occupant to realize that the alert is alerting him or her of the unbuckled seat belt.

25 **[0014]** A third aspect of the invention relates to a method of providing a vehicle occupant with a first audible alert corresponding to a first warning level or a second audible alert corresponding to a second warning level that is higher than the first warning level, to alert the vehicle occupant that his or her seat belt is unbuckled. This method includes the steps of: sounding a first alert chime by repeating an alert sound having prescribed frequency and volume at a first cycle during the first audible alert; and sounding a second alert chime by repeating the same alert sound at a second cycle during the second audible alert.

30 **[0015]** A fourth aspect of the invention relates to a method of providing a vehicle occupant with a first audible alert corresponding to a first warning level or a second audible alert corresponding to a second warning level that is higher than the first warning level, to alert the vehicle occupant that his or her seat belt is unbuckled. In this method, during the second audible alert, an alert chime corresponding to the first warning level is

sounded before an alert chime corresponding to the second warning level.

BRIEF DESCRIPTION OF THE DRAWINGS

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[0016] The foregoing and/or further objects, features and advantages of the invention will become more apparent from the following description of preferred embodiments with reference to the accompanying drawings, in which like numerals are used to represent like elements and wherein:

10 FIG. 1 is a block diagram showing the configuration of a seat belt warning apparatus according to one exemplary embodiment of the present invention;

FIG. 2A is a view illustrating a pattern of generating an audible sound to produce a first alert chime;

15 FIG. 2B is a view illustrating a pattern of generating an audible sound to produce a second alert chime; and

FIG. 3 is a timing chart illustrating one exemplary case for explaining the operation of the seat belt warning system of the embodiment.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] Hereinafter, a seat belt warning apparatus according to one exemplary embodiment of the invention will be described with reference to the accompanying drawings. To comply with the US regulation previously stated, this apparatus is
25 configured to deactivate the primary audible alert within 8 seconds.

[0018] FIG. 1 is a block diagram schematically showing the configuration of a seat belt warning apparatus 100 of the exemplary embodiment. Referring to this drawing, the seat belt warning apparatus 100 includes a buzzer 102 for generating an alert sound, an ECU (Electric Control Unit) 101 that activates an audible alert in response to detecting the
30 seat belt being unbuckled, and a warning light 103 that is on or blinks while the seat belt remains unbuckled. The warning light 103 may individually be provided for each the driver seat and the navigator seat.

[0019] The seat belt apparatus further includes an ignition 104, a driver seat belt buckle switch 105, and a navigator seat belt buckle switch 106. The ECU 101 detects the

state of the ignition 104 being at the ON or OFF position, the driver seat belt buckle switch 105 being ON or OFF, and the navigator seat belt buckle switch 106 being ON or OFF. Also, the ECU 101 detects the vehicle speed via a vehicle speed sensor 107. The driver seat belt buckle switch 105 is ON when the driver seat belt is buckled, and OFF when unbuckled, and the navigator seat belt buckle switch 106 is ON when the navigator seat belt is buckled, and OFF when unbuckled.

[0020] FIG. 2A is a view schematically illustrating generation pattern of an alert sound via the buzzer 102 to sound a "first alert chime", while FIG. 2B is a view schematically illustrating generation pattern of the same chime to sound "second alert chime". Unless otherwise specified, the first alert chime corresponds to the primary audible alert, whereas the second alert chime corresponds to the secondary audible alert.

[0021] The alert sound generated for sounding each alert chime has common frequencies (e.g., 800 Hz and 1.9 kHz), duty ratio (e.g., $D1 = D2 = 50\%$), and sound volume (e.g., 63 dB). Namely, the buzzer 102 generates substantially the same sound for each alert chime.

[0022] In each chime, however, the alert sound is repeated at a different cycle to indicate a specific warning level so that the occupant can distinguish each alert (warning level) by that repetition cycle of the alert sound. In this exemplary embodiment, the first alert chime adopts a repetition cycle $f1$ of 1.2 second, and the second alert chime adopts a repetition cycle $f2$ of 0.4 second.

[0023] Hereinafter, conditions of activating and deactivating each alert will be described. First, the activating conditions will be described. The ECU 101 activates a primary audible alert in response to the driver seat belt buckle switch 105 being OFF upon turning on the ignition 104 to the ON position. Because this is a primary audible alert, for example, the first alert chime continues for 6 seconds ($1.2 \text{ sec} * 5$).

[0024] Then, if at least one of the driver seat belt and the navigator seat belt still remains unbuckled and the vehicle is running at 15 km/h or more after the primary audible alert ends, the ECU 101 then activates the secondary audible alert.

[0025] According to the exemplary embodiment, the secondary audible alert first sounds the first alert chime for 30 seconds, and the second alert chime for 90 seconds. In other words, the same sound is repeated for a total of 120 seconds, during which the cycle at which the alert sound is repeated is shortened. Such repetition of the alert sound makes it easier for the occupant to realize the chime is alerting him or her of the unbuckled seat belt, and then notice by the shortened repetition cycle that the present warning level for

that unbuckled seat belt is higher than the warning level of the primary audible alert triggered upon turning on the ignition 104.

[0026] Also, if the secondary audible alert is timed out with one of the buckle switches being ON and the same switch then turns off, the ECU 101 activates the secondary audible alert again from the first alert chime.

[0027] The ECU 101 ignores satisfaction of the above-stated conditions of activating the primary and secondary audible alerts when the buzzer 102 is sounding each alert chime. That is, under no circumstance, the first alert chime interrupts the second alert chime.

[0028] Next, the deactivating conditions will be described. The ECU 101 deactivates the primary audible alert in response to the ignition 104 being turned to the OFF position, the driver seat belt buckle switch 105 being turned on, or the elapse of the activation time of the primary audible alert (i.e., 6 seconds). Similarly, the ECU 101 deactivates the secondary audible alert in response to the ignition 104 being turned to the OFF position, the driver seat belt buckle switch 105 and the navigator seat belt buckle switch 106 being both turned on, or the elapse of the activation time of the secondary audible alert (90 seconds from the shift to the second alert chime).

[0029] Once the condition of activating the alert is satisfied, the vehicle speed will no more be used as a parameter. That is, once the secondary audible alert has been activated, the ECU 101 will not turn off the buzzer 102 even if the vehicle stops during activation of the alert. Also, even if the vehicle accelerates up to 15 km/h or more after the secondary audible alert has been timed out, the ECU 101 will not turn on the buzzer 102 again.

[0030] FIG 3 is a timing chart illustrating one exemplary case for explaining the operation of the seat belt warning apparatus 100. Referring to the chart, the ignition 104 is turned to the ON position at time t1. Since the driver seat belt buckle switch 105 and the navigator seat belt buckle switch 106 are both OFF at this time, namely the driver seat belt and the navigator seat belt both remain unbuckled, the ECU 101 activates the primary audible alert by sounding the first alert chime via the buzzer 102. To comply with the above-stated US regulation, this audible alert continues for 6 seconds and ends at time t2.

[0031] Then, the vehicle starts running although the seat belts both remain unbuckled, When the vehicle speed reaches 15 Km/h at time t3, the ECU 101 then triggers the secondary audible alert starting with the first alert chime.

[0032] The vehicle stops at time t4. However, since the buzzer 102 is still sounding the first alert chime at this time, the ECU 101 ignores this change in the vehicle speed associated with the stop of the vehicle and continues the first alert chime.

[0033] At time t5, 30 seconds of the first alert chime ends, and the second alert chime starts. Although the navigator seat belt is buckled at time t5, the ECU 101 does not deactivate the secondary audible alert because the driver seat belt still remains unbuckled.

[0034] Subsequently, the driver seat belt is unbuckled and the vehicle speed reaches 5 15 Km/h at time t6. However, this does not satisfy any deactivating condition, so that the ECU 101 continues the second alert chime.

[0035] Then, the vehicle again stops and the driver seat belt is buckled at time t7. At this stage, the ECU 101 turns off the warning light 103 in response to the driver seat belt being buckled, however continues the second alert chime due to the navigator seat belt still 10 unbuckled.

[0036] Then, the driver seat belt is unbuckled and the warning light 103 turns on at time t8. Here, as aforementioned, the ECU 101 ignores satisfaction of any activating condition because the buzzer 102 is sounding the alert chime, and therefore the ECU 101 does not restart the secondary audible alert from the first alert chime in response to the 15 driver seat belt being buckled, but continues the second alert chime.

[0037] At time t9, 90 seconds of the second alert chime ends, namely the secondary audible alert is timed out although both the driver and navigator seat belts remain unbuckled.

[0038] The vehicle speed again reaches 15 Km/h at time t10. However, because the 20 secondary audible alert has been triggered before, the ECU 101 ignores this change in parameter (i.e., vehicle speed).

[0039] When the vehicle stops and the ignition 104 is turned to the OFF position at time t11, the ECU 101 turns off the buzzer 102.

[0040] The ignition 104 is again turned to the ON position at time t12. Because both 25 the driver and navigator seat belts remain unbuckled at this time, the ECU 101 turns on the warning light 103 and activates the primary audible alert sounding the first alert chime via the buzzer 102.

[0041] At time t13, the alert mode immediately shifts from the primary audible alert to the secondary audible alert in response to the vehicle speed reaching 15 Km/h. In the 30 initial stage of the secondary audible alert, as aforementioned, the ECU 101 first sounds the first alert chime for 30 seconds, and starts the second alert chime at time t14.

[0042] Subsequently, the driver and navigator seat belts are both buckled at time t15 while the vehicle is still running. Because this satisfies the condition of deactivating the secondary audible alert, the ECU 101 immediately turns off the buzzer 102 sounding the

second alert chime.

[0043] Then, the navigator seat belt is unbuckled at time t16, and therefore the secondary audible alert is again activated from the first alert chime.

5 [0044] This chime lasts 30 seconds and the cycle at which the alert sound is repeated is changed at time t17 (i.e., the beginning of the second alert chime). At time t18, which is 90 seconds after time t17, the secondary audible alert is timed out due to the navigator seat belt still unbuckled.

10 [0045] At time t19, the ECU 101 re-triggers the secondary audible alert from the first alert chime in response to the driver seat belt being unbuckled, since the last secondary audible alert was timed out with the driver seat belt buckled.

[0046] Although the navigator seat belt is buckled at time t20, the first alert chimes continues since the driver seat belt still remains unbuckled. The second alert chime starts at time t21 which is 30 seconds after time t19, and the secondary audible alert is timed out at time t22 which is 90 seconds after time t21.

15 [0047] Thus, the secondary audible alert is timed out with the navigator seat belt buckled. Therefore, the ECU 101 activates the secondary audible alert again from the first alert chime at time t23 in response to the navigator seat belt being unbuckled.

20 [0048] According to the exemplary embodiment, as described above, the ECU 101 sounds the same chime via the buzzer 102 in the initial stage of the secondary audible alert as during the primary audible alert that the occupant usually hears when starting the vehicle. Therefore, the occupant can readily realize that his or her seatbelt is unbuckled at the beginning of the secondary audible alert.

25 [0049] Also, during the secondary audible alert, the cycle at which the alert sound (i.e., sound of the same frequencies and volume) is repeated is shortened. This makes the occupant notice that the present warning level for the unbuckled seat belt becomes higher than the primary audible alert, while assuring the correct recognition of the occupant as to the unbuckled seat belt warning.

30 [0050] While the invention has been described with reference to the exemplary embodiments thereof, it is to be understood that the invention is not limited to the preferred embodiment or construction. To the contrary, the invention is intended to cover various modifications and equivalent arrangements. In addition, while the various elements of the preferred embodiments are shown in various combinations and configurations, which are exemplary, other combinations and configurations, including more, less or only a single element, are also within the spirit and scope of the invention.